Mastercourse

Metallurgical Engineering

(Ferrous Process Metallurgy)

2007-10-18

Last name, first name: **Matrikel-Nr.:**

Signature:

Task	Points (max.)	Points	Signature	Approval	Finalpoints (total)
1	**5**				
2	**5**				
3	**5**				
4	**5**				
5	**5**				
6	**5**				
7	**5**				
8	**5**				
9	**5**				
10	**5**				
Total:			**Total after approval:**		

Mastercourse

Metallurgical Engineering

Univ. Prof. Dr.-Ing. Dieter Senk **2007-10-18**

1. Task: Pelletizing und Sintering **5 points**

a) Name methods and aggregates used for the production of pellets of fine ore.
(at least 4 answers)

2,0 points

b) Name 6 characteristic zones of the sinter layer on the sintering belt during the sintering process.

3,0 points

2. Task: Metallurgical Coke 5 points

a) What are the “volatile components” of coal?

0,5 points

b) What are the main components of coke oven gas? (at least 5 answers)

2,5 points

c) Which 2 methods can be used to cool down hot metallurgical coke? Give a short description of both methods.

2,0 points

3. Task: Blast Furnace 5 points

a) What is the “cohesive zone” in the blast furnace?

0,5 points

b) What are “direct reduction” and “indirect reduction” in the blast furnace? What is the temperature-limit between these reduction types?

1,5 points

c) Sketch the blast furnace profile (longitudinal section of a blast furnace) and name the 5 furnace parts.

3,0 points

4. Task: Thermodynamics 5 points

a) Use the law of Heß for calculating the change of enthalpy of the following reaction.

$$Mn_{(F)} + C_{(F)} + \frac{3}{2} O_{2(G)} = MnCO_3$$

Given:

$2Mn_{(F)} + O_{2(G)} = 2MnO_{(G)}$ ΔH_{800K}= -767,083 kJ/mole

$C_{(F)} + O_{2(G)} = CO_{2(G)}$ ΔH_{800K}= -394,153 kJ/mole

$MnCO_{3(F)} = MnO_{(F)} + CO_{2(G)}$ ΔH_{800K}= +111,395 kJ/mole

2,0 points

b) Give an example for the 1. and the 2. Law of Thermodynamics in the iron and steel metallurgy.

2,0 points

c) Is the entropy change during gasification of coal more or less than 0 ?
Why?

1,0 points

5. Task: Steel converter 5 points

a) Name 4 feeding materials and 3 products (also gases) of the BOF converter process.

3,5 points

b) What are the tasks of lime during steelmaking in the BOF converter? (at least 2 answers)

1,0 points

c) What`s the value of the typical tapping temperature of BOF converters?

(Only one answer (cross) is allowed) **0,5 points**

- ☐ 1300°C
- ☐ 1400°C
- ☐ 1700°C
- ☐ 1900°C
- ☐ 2000°C

6. Task: Direct and Smelting Reduction 5 points

a) The operator of a Midrex plant obtained a different kind of iron ore. The chemical analysis of the iron ore is given in the tabular below. Calculate the theoretical demand of reducing gas (STP) per ton of iron ore if conversion is complete. The reducing gas contains 80 % CO and H_2 and 20 % N_2. What is the amount of metallic iron after reduction if metallisation is complete?

5,0 points

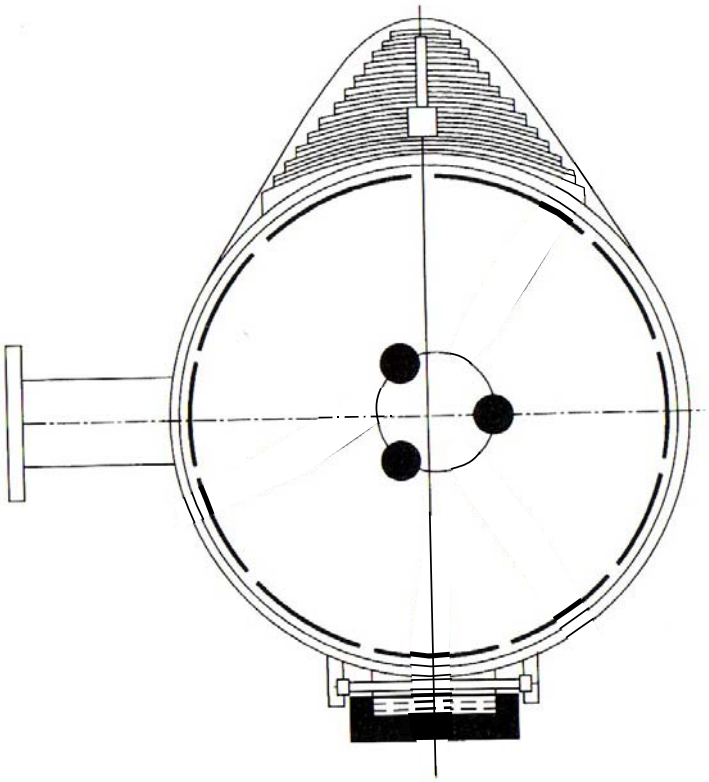
Chemical composition of iron ore in wt-%

Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO	P	S	Na_2O	K_2O	Mn	TiO_2	Other
92,68	6,3	0,31	0,07	0,06	0,02	0,01	0,01	0,01	0,02	0,24	0,27

7. Task: Electric Steelmaking 5 points

a) Electric arc furnaces can be operated by use of 4 burners. Sketch standard positions of these burners into the drawing below.

2,0 points



b) Which kinds of energy are implemented in electric arc furnaces? (at least 2 answers)

1,0 points

c) Where are the positions of the electric arc and how does energy transfer work in

- an AC-EAF and
- a DC-EAF?

2,0 points

8. Task: Secondary Metallurgy: 5 points

a) Name an equation describing the pressure dependency of nitrogen solubility in steel melts.

1,0 points

b) Name and describe the two standard processes to heat steel melts and give for each of these processes at least 2 advantages and 2 disadvantages.

3,0 points

c) Give the 2 most important oxides describing the basicity of metallurgical slags.

1,0 points

9. Task: Continuous Casting 5 points

The strands of a two-strand-continuous caster have the dimensions of 1785 mm by 250 mm and a metallurgical length of 35,15 m. The casting speed is at constantly 0,75 m/min. The density of the liquid steel amounts 7 g/cm³, the density of the solid and hot steel amounts 7,4 g/cm³

a) Calculate the so-called casting constant k.

2,5 Points

b) How much is the production per year? It is considered that this caster shuts down for 25 full days per year and produces the other time.

2,5 Points

10. Task: Protection of Environment, Recycling 5 points

a) Give a definition for sustainable development.

1,0 points

b) Name 4 potentials for reducing the energy consumption in the iron and steel industry.

2,0 points

c) Name 4 residual or circulating materials in iron and steel production.

2,0 points